J1.26

INTERACTIVE ACCESS TO DISTRIBUTED *IN SITU* DATA IN A COLLABORATIVE TOOL ENVIRONMENT

Donald W. Denbo*[1], Chris R. Windsor[2]
[1]Joint Institute for the Study of Ocean and Atmosphere, University of Washington, Seattle, WA,
[2]MacroStaff, Bellevue, WA

1. INTRODUCTION

The collaboration of scientists that are not located at the same site poses many difficulties. The old paradigm of mailing, faxing, or ftp-ing documents and graphics is unwieldy and cumbersome. The process of analyzing and interpreting data often involves significant discussion between collaborating scientists. Presently these discussions must take place in person to effectively exchange information regarding graphical representations of data and analysis products. These communications are much less effective when they take place via mail (electronic and/or postal) or phone. The loss of communicative effectiveness is primarily due to the difficulty and imprecision of a strictly verbal exchange regarding graphical information, e.g. indicating a specific minimum in temperature from a CTD cast.

Removing the major barriers to effective collaboration between scientists not located at the same site, will improve the discussions that scientists can conduct about data and analyses. Scientists working on problems related to describing, monitoring and predicting changes in the Earth's environment are located across the country. Improvements in communication will translate into improved science.

2. DESIGN GOALS

The collaborative application will need the following capabilities to create an effective collaboration tool with *in situ* data sets.

- Provide an interactive and collaborative environment for *in situ* data exploration.
- Allow co-plotting of data from multiple, geographically distributed archives.
- Allow data from local files (netCDF) to be read.
- Enable scientists to interactively annotate data.
  - Highlight individual profiles
  - add text, arrows, lines, etc.
- Enable scientists to interact with the data.
  - Query values
  - Query metadata (geographic location, etc.)

3. APPROACH

The development of OceanShare, the collaborative tool, leverages from the collaborative tools and framework developed at NCSA under the Habanero project and the development of integrated graphics of data sets from multiple archives at different locations under the NOAAServer project (Daddio et al., 1999; Soreide and Daddio, 1998).

3.1 *NCSA Habanero*

Habanero is a framework for sharing Java objects with colleagues distributed around the Internet. Included, or planned, are all the networking facilities, routing, arbitration and synchronization mechanisms necessary to accomplish the sharing of state data and key events between collaborator's copies of OceanShare. Authentication and privacy features are also available. There is no inherent limit in the number of tools per session, nor is there a limit on the type of tools that may be shared. NCSA Habanero tools which may be utilized include a whiteboard, a collaborative text editor, and various chat utilities. Habanero is available at "*http://www.ncsa.uiuc.edu/SDG/Software/Habanero*".

3.2 *NOAAServer*

The NOAAServer project has developed a mechanism to locate, subset, and transfer data sets distributed over many servers (Denbo et al., 1998). This mechanism uses an object oriented data model and CORBA/IIOP implementation for data access. OceanShare uses the CORBA servers and client software developed by NOAAServer for distributed data access.

The Scientific Graphics Toolkit (sgt), was also developed within the NOAAServer project (Denbo, 1999). Sgt provides the graphics engine for OceanShare. Sgt is available at "*http://www.epic.noaa.gov/NOAAServer/sgt*".

4. OCEANSHARE ARCHITECTURE

OceanShare has three primary architectural components, data access, Habanero events, and graphics (Fig. 1)

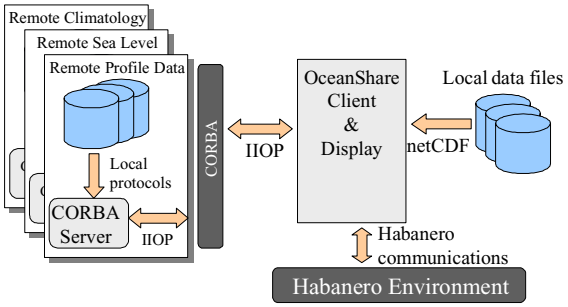

Figure 1. OceanShare architecture.

* *Corresponding author address:* Donald W. Denbo, NOAA/PMEL/OCRD, 7600 Sand Point Way NE, Seattle, WA 98115; e-mail: dwd@pmel.noaa.gov

4.1 *Data Access*

The basic data access architecture is presented in Fig. 2. Observational data can be loaded into OceanShare

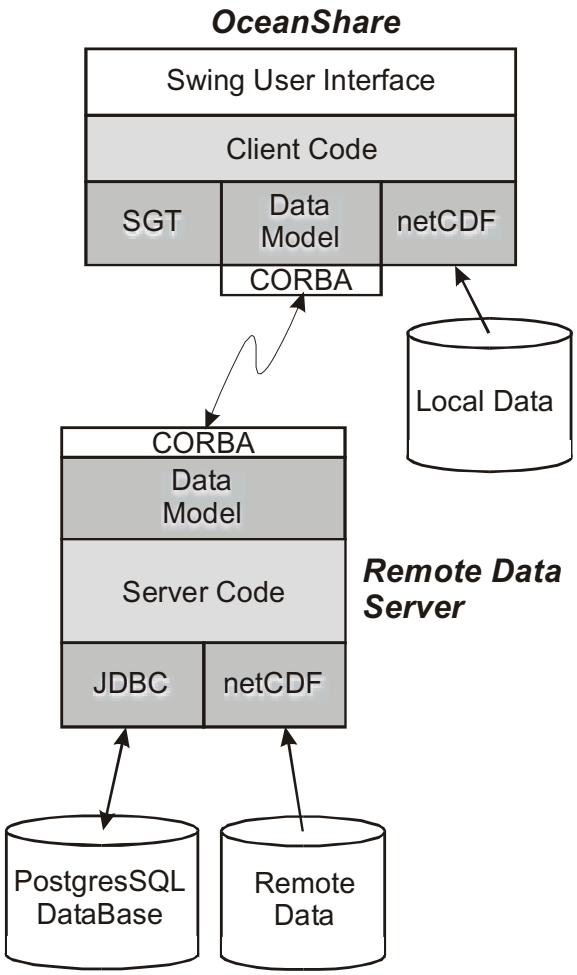

Figure 2. OceanShare software modules.

either from local netCDF data files or from remote data servers that support the NOAAServer remote data model. The module responsible for data access takes either the local or remote data and packages it into objects that can be directly used by sgt then hands these data objects back to OceanShare. The details of data origin are hidden from both the graphic and collaborative aspects of OceanShare.

The separation of data access from display and collaboration will allow us to easily extend OceanShare to modify existing data access (e.g. CORBA to RMI) or add new data access capabilities (e.g. read local ascii files).

4.2 *Collaboration*

The Habanero framework is responsible for the collaborative aspects of OceanShare. OceanShare is responsible for posting the events to Habanero in response to a users actions. We have chosen not to post low-level events to Habanero, thus reducing the amount of communications. For example, when loading data, OceanShare takes the user though a series of dialogs to identify the data subset to load. Only after a subset has been loaded and packaged into objects are the other clients notified with an ADD_PROFILE event that contains the data objects.

Habanero event handling is demonstrated in Fig. 3. In

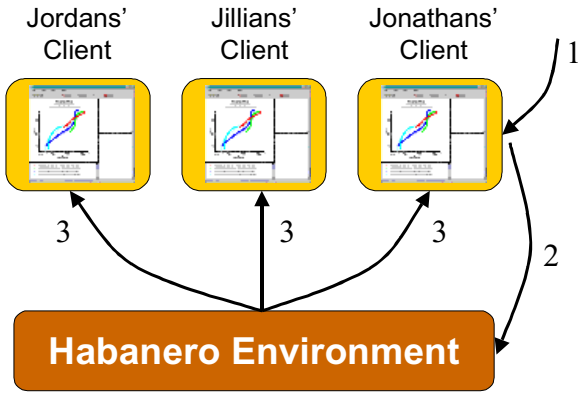

Figure 3. Event flow in the Habanero framework.

this scenario 1) Jonathan selects a profile to be highlighted, 2) OceanShare posts the event to Habanero, then 3) Habanero sends the event to Jordans', Jillians', and Jonathans' client. (Note: Habanero also sends the event to the originator!) OceanShare is responsible for identifying what event was sent by Habanero and then taking the appropriate action. In this example, highlighting a profile.

4.3 *Graphics*

OceanShare uses the scientific graphics toolkit (sgt) to provide data visualization capabilities. Sgt was developed primarily to provide client-side graphics for the NOAAServer project (Denbo, 1997, 1999). Sgt provides the following features:

- Allows graphics client developer a great deal of flexibility and freedom.
- GIS style layer approach to display geophysical data
- Support several types of graphical display
  - X-Y plot
  - 2-D contour and "pixel" plots.
  - Vector plots.
  - Point-Value plots.
- Develop a framework that is easily extended

Sgt is written in java and includes features that enable an application to implement zooming, object selection, and object positioning. OceanShare uses these features to implement profile highlighting, moveable pointers for each user, and a value icon. The value icon consists of a

cross-hairs icon and the temperature and depth values for the icon's center.

5. OCEANSHARE EXAMPLE

The design and architecture described above has been implemented in a collaborative application called *OceanShare*. (More information about obtaining and installing OceanShare can be found at "*http://www.epic.noaa.gov/collab*".) The following screen dumps demonstrate some of the capabilities of OceanShare.

5.1 *Network Data Load*

When loading data from a distributed data set the remote data selection wizard (Fig. 4) is displayed. The

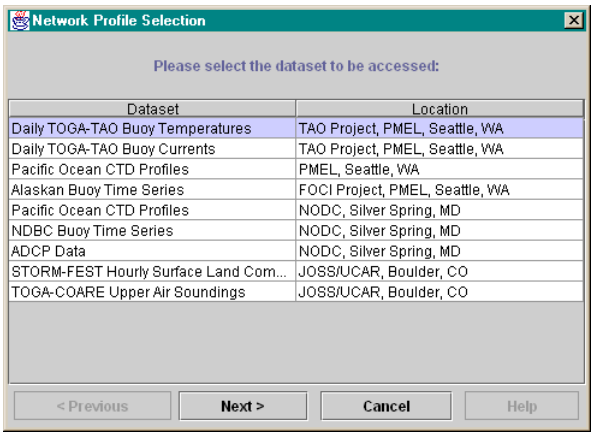

Figure 4. Data sets available via CORBA servers.

user selects the data set of interest and then is guided through a series of panels to choose the profile, depth range, and variable to be loaded. While OceanShare can presently only load profile data, the NOAAServer CORBA servers are capable of providing time series and depth-time sections.

5.2 *Local Data Load*

OceanShare can load local data one file at a time or multiple data files by using a pointer file (a file that contains an absolute file reference per line). When a pointer file is specified, OceanShare opens each data file to read the latitude, longitude, and variables. (Fig. 5). The user may select multiple data files, but only a single variable. As profiles are selected from the table on the left, the right hand table is updated to include only the variables available in the highlighted data files.

5.3 *OceanShare Application*

The OceanShare main window is show in Fig. 6. The main window consists of four panels. The upper-left panel provides the graphical display of the profiles and allows the user to position pointer icons that are linked to the plot (the icons move with the data when zooming the plot region). The lower-left panel contains the line key.

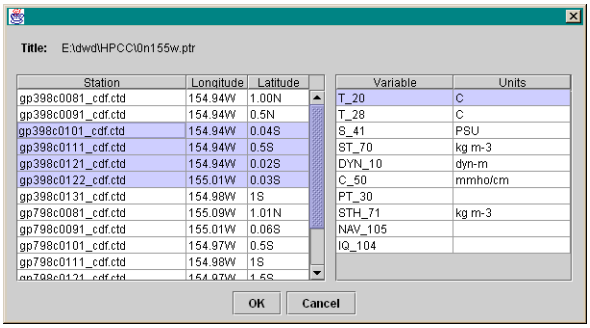

Figure 5. Local data access (netCDF).

The key contains salient metadata for the profile (latitude, longitude, time). Selecting a key entry enables the user to highlight a profile. Metadata from the highlighted profile is displayed in the upper-right panel. Network connection information is displayed in the lower-right panel.

6. FUTURE DIRECTIONS

We plan to expand the capabilities of OceanShare over the next year. New features will include:

- Allow user to create annotations both textual and graphical.
- Load and plot time series and section data.
- Save the current state of OceanShare to a file. This includes data, annotations, and icon locations.

Acknowledgment. This publication is funded partially through the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) under NOAA Cooperative Agreement NO. NA67RJ0155, Contribution No 728. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its subagencies. This work was funded by NOAA's HPCC program.

7. REFERENCES

Daddio, E., S. Hankin, N. Soreide, D. Denbo, W. Zhu, S. Roberts, J. Sirott, and S. Rosenberg, 1999. NOAAServer: Unified access to distributed NOAA data. In *15th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*, Dallas, Texas, AMS, 10-15 January 1999, 430-433.

Denbo, D.W., 1999. Using Java graphics to display ocean observations in NOAAServer. In *15th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*, AMS, Dallas, TX, 10-15 January 1999, 442-444.

Denbo, D.W., S. Hankin, J. Sirott, and W.H. Zhu, 1998. A unified browse environment for NOAA's data using distributed objects. In *Marine Technology Society/*

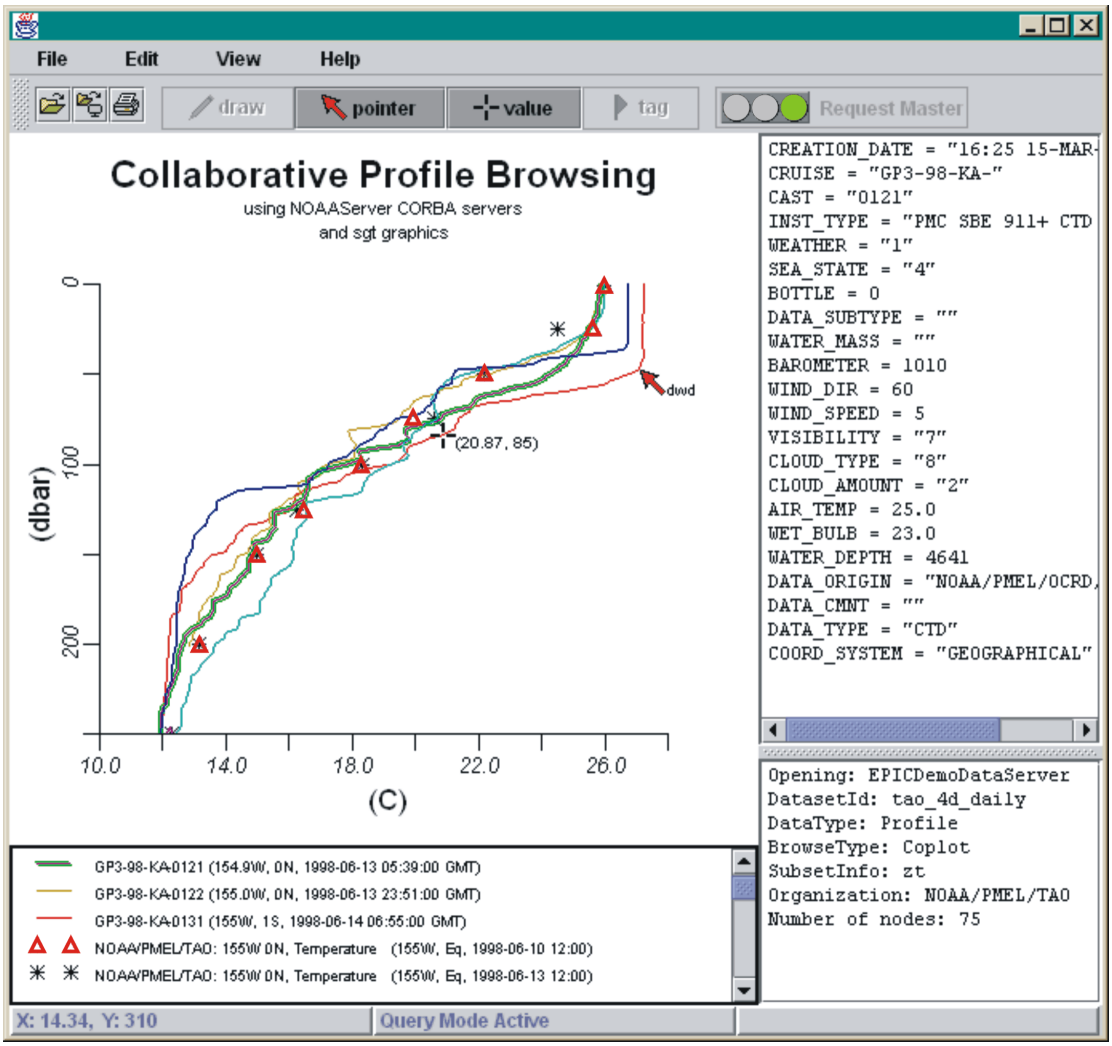

Figure 6. OceanShare main window.

Ocean Community Conference '98, Baltimore, Maryland, 16-19 November 1998.

Denbo, D.W., 1997. NOAAServer Graphics Engine Architecture. Presented at *NOAA WebShop97*, October 22-23, 1997, Silver Spring, Maryland.

Soreide, N.N., and E. Daddio, 1998. NOAAServer: Unified access to distributed NOAA environmental data. In *Marine Technology Society/Ocean Community Conference '98*, Baltimore, MD, 16-19 November 1998.